Schofield G, Schofield T.

Exploring Space with Field Venturer.

In: Research Through Design (RTD 2017). 2017, Edinburgh, UK

DOI link to article:

http://doi.org/10.6084/m9.figshare.4746949

Date deposited:

17/05/2017

Proceedings of the 3rd Biennial
Research Through Design Conference

Exploring Space with FieldVenturer

Guy Schofield and Tom Schofield

Schofield, G. & Schofield, T. 2017. 'Exploring Space with FieldVenturer'.
In: Proceedings of the 3rd Biennial Research Through Design Conference,
22-24 March 2017, Edinburgh, UK, Article 07, pp. 98-113.
DOI: 10.6084/m9.figshare.4746949.

Image credit: Guy Schofield.

Exploring Space with *FieldVenturer*

Guy Schofield [1], Tom Schofield[2]

[1] Department of Theatre, Film and Television, University of York, York, UK
guy.schofield@york.ac.uk

[2] Culture Lab and Fine Art, School of Arts and Cultures, Newcastle University, Newcastle, UK
tomschofieldart.gmail.com

Keywords: drone; UAV; rover; remote-control; interface design; DIY

Abstract: *FieldVenturer* is a project experimenting with a long-range remote-controlled and collaboratively-piloted vehicle. It centres on the design, development and public deployment of a Rover: a small tracked vehicle equipped with sensors and a camera and an elaborate 'Command Centre' through which it can be controlled by members of the public. Through a series of *FieldVenturer* events, we are beginning to explore how experiencing spaces through a 'drone's eye view' can play a part in promoting discussion around the reconfiguration and re-articulation of public spaces. Through an interface that involves different temporal approaches to control and feedback we are also beginning to explore how varying the pace of interaction along multiple timescales can affect how spaces are experienced.

Introduction

FieldVenturer is a project experimenting with a long-range remote-controlled and collaboratively-piloted vehicle. It consists of two distinct elements: a small DIY vehicle (referred to throughout this paper as the Rover) and the Command Centre: an installation built around a computer interface from which the Rover can be operated. Controlled wirelessly over the internet, the Rover can be controlled from anywhere in the world and is designed to explore a range of spaces.

FieldVenturer is a project by FieldVentures; a collaboration between Guy and Tom Schofield Schofield and Schofield are artist/researchers working across the disciplines of media art, film, visual effects and Human Computer Interaction research. Over the past five years we have periodically used FieldVentures as a space to collaborate on projects that occur at the intersection of our individual research interests.

The project was funded as part of an event by the Baltic Centre for Contemporary Art to coincide with a series of exhibitions in which debates around drones and autonomous vehicles were foregrounded (Baltic 2016). *FieldVenturer* was used to link Baltic's two gallery complexes, sited in different parts of the city. During an evening opening event, visitors were invited to visit the Command Centre at Baltic's smaller gallery and control the Rover as it roamed around a space at

Figure 1. First deployment of *FieldVenturer*. Photo: Schofield & Schofield.

the larger site, 3km away (see Figure 1). From the Command Centre, controllers could use a web interface to direct the Rover using a series of point-and-click commands while receiving near-real-time feedback from its camera and sensors.

In developing the *FieldVenturer* project, we wanted to begin to explore the complex constructions of public and private space engendered by remotely-piloted vehicle technologies. In particular we were concerned with two formal constraints to the exploration of such constructions. Firstly we were interested as to how we might channel the popular adoption of FPV (first person view) camera feeds from remotely-piloted vehicles into an interactive exploration of space from ground level. Secondly we were motivated to consider how temporal issues of remote interaction might nuance the experience of the exploration of space.

We conceived an interest in how a DIY vehicle could be constructed, deployed and operated by untrained 'pilots' in public settings. We also wanted to use the project to unpack our own ongoing fascination with some of the visual tropes involved which, as we will see later in this paper, presents a number of interesting problems.

Motivations: Rovers/Probes/Drones

Remote controlled vehicles are a relatively new phenomenon and have for much of their history been inextricably intertwined with military and industrial interests. Their use in contemporary society is uniquely controversial: in particular unmanned air vehicles (UAV) or drones have become symbolic both of the growing use of surveillance through technology and of morally questionable military actions. Since before WW1, the impetus for the development of unmanned vehicles has often come from the military, with the development of semi-autonomous jet aircraft and rockets in the 1940s feeding directly into both US and Soviet space programmes (Siddiqi, 2000). In this sense, drones are metonymical for broader issues of technological development and the continuing strong connections between research labs and military funding. As artist/researchers practicing within an extended ecosystem of such labs we have an active interest in the uncomfortable relationship between technical innovation and military money. In this project and others we explore have explored aspects of military technologies through established artistic strategy such as detournment, pastiche and mimicry.

Of particular interest to us, is the historical connection between robot vehicles and the contestation and articulation of space, a connection which has, over the last hundred or so years played out at a variety of scales, ranging from the privacy of citizens' back yards through the exploration and surveillance of the Earth's surface to the emerging mapping and political appropriation of the solar system. During the 1960s and 1970s, NASA probes were sent out into the solar system followed by space telescopes such as SOHO and Hubble (Domingo, 1995): remote-controlled vehicles designed to gather knowledge from places inaccessible to human beings. Meanwhile, ROVs or Remotely Operated Vehicles became routinely used in both marine science and oil exploration (Christ and Wernli, 2013). More recently NASA and ESA have developed and successfully launched elaborate wheeled vehicles or rovers designed to act as both explorer and laboratory in the unforgiving environment of Mars (Kaufman and Musk, 2014).

While these missions have been driven by a combination of political competition and scientific enquiry, other uses of robotic vehicles have been more directly motivated by politics. The Strategic Defense Initiative or 'Star Wars' programme developed under the Reagan Administration conceived of robot sentinels, protecting the capitalist West from Soviet nuclear weapons (Lakoff and York, 2009). More recently, UAVs have been used extensively in conflicts in the Middle East (Bleicher, 2010). These drones, controlled via satellite from installations in the USA are seen as a low-risk alternative to manned aircraft, allowing Western powers to exercise military power across the globe without fear of losing personnel.

We are, of course, not the first artists or researchers to explore this particular space. Unpiloted vehicles of every sort have also provided a rich context for artistic exploration and political activism. As early as 1996 Greg Green's *Gregnik* project in Meadow Well, Tyneside explored the idea of public appropriation of space technology (Green, 1996). The project saw the design and deployment of a fully functioning communications satellite in an unlikely setting: a community centre in a deprived estate in North East England. Chris Csikszentmihalyi's *Freedom Flies* and *Afghan-eXplorer* (2009) both involved the development of remote controlled vehicles to reconfigure contested spaces. More recently *Project Daedalus* is attempting to democratize the use of drone technology by providing resources for artists and curators wishing to explore this area (AND, 2016).

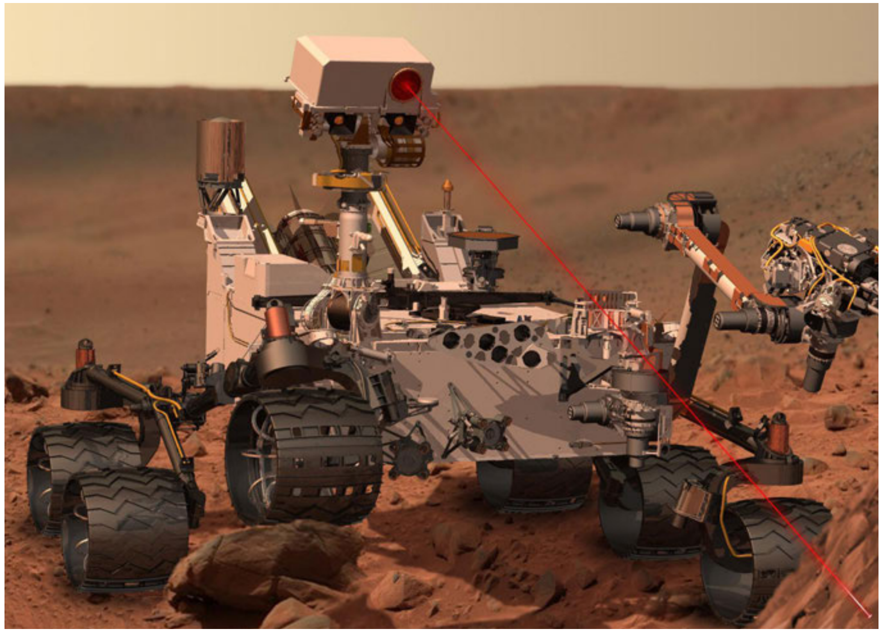

Figure 2. Curiosity Rover. Photo: NASA Jet Propulsion Laboratory.

Designing and Building *FieldVenturer*

The projects described above all deal with the appropriation of remote control or autonomous vehicle technologies by citizens, in many cases towards a direct political end. In the case of *FieldVenturer*, we had a more exploratory approach in mind. We wanted to build a system that had aspects of the functionality of, say, a NASA Rover but was simple and safe enough to operate that members of the public could play and experiment with it without training. Crucial to our approach was that the Rover itself should be accessible from a great distance - far beyond line of sight - and should be able to explore unfamiliar spaces. It should also be controlled with a sense of temporal disjunction: i.e. operators should send it a command (forward, turn left etc) and receive a delayed response. This was in line with our interest in considering the unusual temporal affordances of such remote interaction and their effect on the exploration of architectural space. We hoped that this delay between action and result might foster planning, collaboration and reflection on the part of its operators

The Rover

The *FieldVenturer* Rover is designed to be a flexible platform for exploring different spaces. Two small, geared 7v motors and a pair of configurable gearboxes drive its caterpillar tracks. In the rear of its chassis are located a pair of Arduino microcontrollers, one of which supplies current to the motors while the other receives commands and transmits data via an onboard wireless transceiver. The two are connected by a simple two-wire communication, ‘i2c’ (http://learn.sparkfun.com). This two board arrangement was made necessary by the various power and connectivity demands of our setup.

Set into the nose of the Rover is a smartphone, enabling live video to be streamed from the vehicle. In the top of the vehicle, four sensors are mounted, currently measuring carbon monoxide, barometric pressure, gas alcohol and methane (see Figure 5). All of the remaining upper surfaces of *FieldVenturer* are covered by removable hatches, which can easily be adapted to carry other sensors.

FieldVenturer relies on very basic electronics which are designed to be emulated by any interested amateur. Circuit diagrams and part lists are also available on the project’s source code repository .Designed using CAD software and constructed from laser-cut acrylic, *FieldVenturer* measures nearly half a metre long and stands 270mm high (see Figure 3). The reasons for its large size are threefold. Firstly, we wanted it to be flexible enough to deploy in a range of spaces, without being restricted by terrain. The Rover has sufficient ground clearance and traction to climb over kerbs, small steps and other minor obstacles.

Secondly, we wanted enough space inside the vehicle to carry additional sensors and electronics in future projects. Its motors, microcontrollers

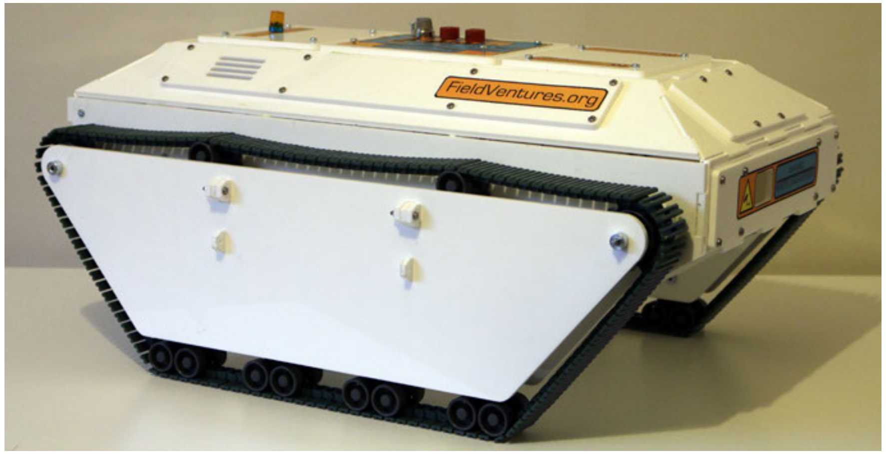

Figure 3. The *FieldVenturer* Rover. Photo: Schofield & Schofield.

and batteries occupy only a tiny proportion of its interior space. Thirdly, we wished it to have a noticeable presence in public situations: both to draw the eye and –importantly– to avoid being trodden on by members of the public.

FieldVenturer relies on a fairly complex software architecture with many connected elements (simplified in Figure 4). The main communication board in the vehicle is an Arduino Yun. This microcontroller consists of two chips which are joined together with a 'bridge'. One is a 'normal' Arduino which is responsible for communicating with attached physical devices (such as sensors). The other runs a version of linux. In our setup, this linux system runs a simple server written in nodejs (http://node.js.org). This communicates with clients attaching to it and forwards sensor data received from the Arduino chip side. Because the vehicle is designed to be deployed in public space through networks over which we have no administrative control, we use a tunnelling service 'yaler'(http://yaler.net) to avoid firewall restrictions.

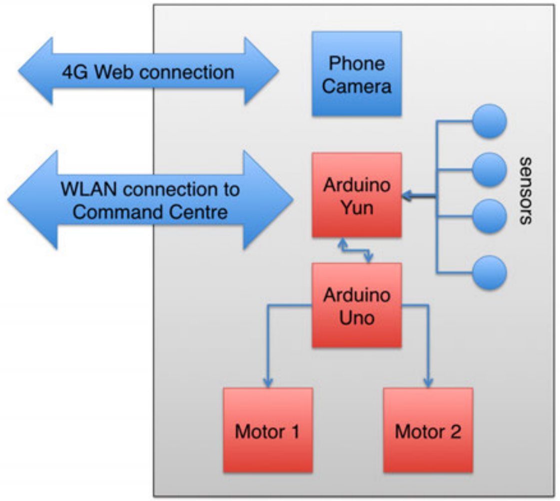

Figure 4. Major connections within *FieldVenturer* Rover. Photo Credit: Schofield & Schofield.

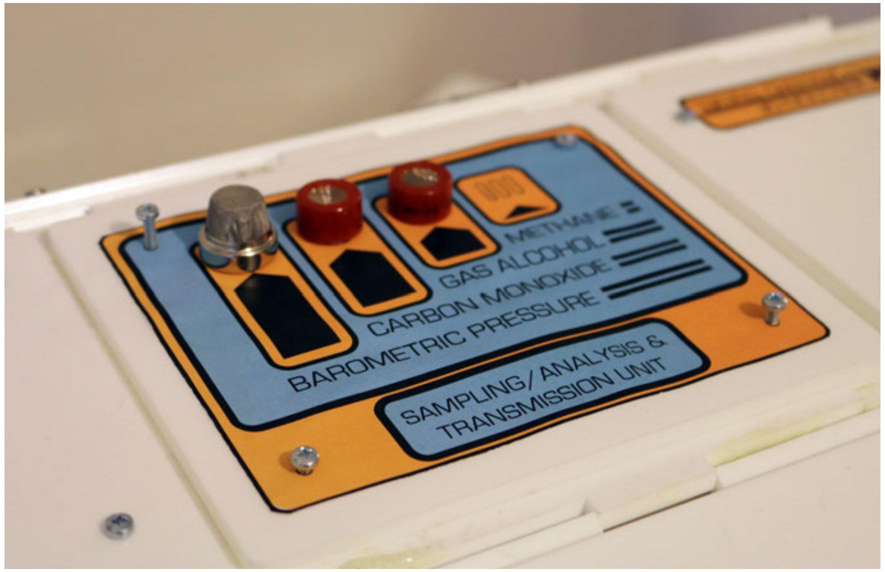

Figure 5. Detail of the Rover's sensor array. Photo: Schofield & Schofield.

Figure 6. Command Centre installation. Photo: Schofield & Schofield.

Figure 7. Young visitors play hide and seek with pilots via the Rover’s camera. Photo: Schofield & Schofield.

Command Centre Interface

The interface was written using browser technologies which allowed a very quick development time. GUI buttons which control the vehicle and incoming data streams are connected to the nodejs server (and consequently to the vehicle) using websockets and socket.io (http://socket.io) connecting to a local proxy. The data is bound to SVG and HTML elements using JavaScript frameworks such as jquery (http://jquery.com) as sparkline graphs and other UI facets. In addition this data is sonified using a combination of basic oscillators (sine, square, saw and triangle wave forms) creating a noisy and dynamic buzz. In FieldVenturer_01: the vehicle’s first outing, the interface was projected on the front wall of a gallery space, enabling members of the public to see the interactions taking place between each ‘pilot(s)’ and *FieldVenturer* (see Figure 6). In this case, two side panels also displayed pre-rendered visuals which gave contextual information about the project, including a map of the vehicle’s location, photographs and diagrams of its appearance and details of its construction.

FieldVenturer_01: A first deployment.

FieldVenturer’s first mission: FieldVenturer_01 was an opportunity to test some of these decisions. As discussed above, FieldVenturer_01 was part of a citywide evening art event in which members of the public could visit both the Command Centre and the site that the Rover was exploring. The event was relatively brief, lasting from 5pm to 10pm. During this time, the installation ran continuously, and several hundred members of the public visited the Command Centre with a smaller number visiting the Rover itself.

Exploring and Play

We found that the slow movement of the Rover and the delayed response from the video feed quickly fostered discussion about what was live, delayed or happening in real time. Visitors soon noticed that although the vehicle responded almost instantaneously to commands (as displayed through the graphs of the GUI), the video stream was slow to update, typically running 3-5 seconds behind. They also quickly learned to exploit the affordances of the Command Centre and the Rover. Some members of the public used the Rover to communicate explicitly with each other, waving to the camera (see Figure 10) or holding up messages. Other visitors tried to respond with gestures: moving the Rover from side to side, or attempted to use the vehicle to follow the visitors at the Rover site. Several members of the public at the Rover site set challenges for their counterparts at the Command Centre, constructing obstacles, ramps and slaloms for the Rover to negotiate (see Figure 8).

Much of the activity at the Command Centre site was centred on using the Rover to explore the space. The gallery in which the Rover was running was an education space, furnished with chairs, tables and various children's activities including puzzles, toys and even a full size wooden boat. The slightly grainy monochrome video feed combined with the very low camera angle de-familiarised even common objects, making the process of navigating the space disorienting.

Collaboration and Performance

The layout of the Command Centre at Baltic meant that in operating the Rover, visitors were willingly participating in a type of collaborative and improvised performance. The slow movement of the Rover, the latency of the video stream and the laborious action/response control scheme

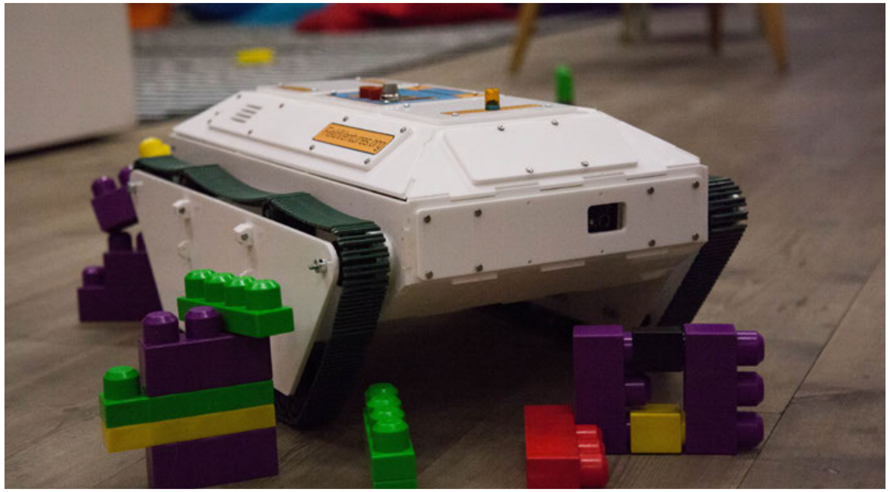

Figure 8. The Rover negotiates obstacles laid by members of the public. Photo: Schofield & Schofield.

facilitated pauses for thought and cooperation between operators. Visitors argued over choices of route, helped each other identify objects and suggested new challenges for each other.

The interface through which the Rover was piloted was placed centrally in a large white-walled and high-ceilinged gallery space. Many viewers entering the Command Centre stayed at the back of the space and watched others piloting the vehicle before approaching the focal point of the room: the control interface. Few needed guidance in operating the vehicle; the information presented in the projections and the simple control scheme meant that most visitors immediately grasped how each element worked. We found that visitors would often pass on instructions and guidance to each other as they handed over control from one group to another.

The sounds produced from *FieldVenturer's* sensors not only contributed to the atmosphere in the Command Centre but also provoked conversation between visitors as they tried to connect the changing soundscape with the visual representation of the sensor data on the projections. The sounds also functioned as an instantly noticeable indication of something happening. Visitors near the Rover leaning down to breathe on the CO2 sensor would cause a sudden spike in pitch, immediately attracting visitors to the interface at the Command Centre site.

Figure 9. A family discusses how to negotiate an obstacle. Photo: Schofield & Schofield.

Discussion

Working with Space and Time

By far the most compelling aspect of *FieldVenturer's* first outing was the way in which it defamiliarised and recontextualised the public space in which the Rover was situated. The positioning of the camera at near ground level was central to the experience of space produced by the vehicle and its remote interface. As we have indicated, so-called FPV cameras increasingly assume a central position in the surrounding visual culture of remote controlled vehicles in both leisure and military pursuits. In the former, FPV quadcopter racing (where competitors typically wear head-mounted displays) has grown in popularity to be an internationally organised activity with a recent contest held in Dubai giving one million U.S. dollars in prize money . In military contexts advanced control centres

Figure 10. A visitor communicates with the Command Centre via the Rover's camera. Photo: Schofield & Schofield.

combine FPV with a range of contextual sensor data positioning the pilot at a complex nexus of ways of seeing. What is notable about this aerial perspective is the way that it affords a dehumanised form of seeing, at its worst informing 'a sense of moral and all-seeing superiority' (Graham, 2016). Facets of this perspective have found their way into art practice emphasising the effect on the ground of views from the sky (Benedictus, 2014; Bridle, n.d.) in particular for the victims of drone attacks.

By contrast the *FieldVenturer's* camera presented an ants'-eye perspective. Its focus was on the micro rather than the macro view of its environment and many visitors enjoyed exploring features particular to this perspective: the underneath of chairs, piles of toy bricks etc. For visitors to the Command Centre, piloting *FieldVenturer* was a performative and collaborative act allowing an unusually discursive and deep engagement with a public space. During the deployment, visitors discussed what they were seeing, helped each other solve spatial problems and suggested areas of the space to explore. They navigated the space in collaboration and used furniture and architectural details as sites for play, communication and exploration.

This experience seemed to be encouraged by the Command Centre itself. The space was more or less empty except for the materials of the installation. These were installed on flight cases or trestle tables emphasising the sense of a temporary site of action. The combination of loud audio from the incoming sensor data developed the atmosphere and contributed to the sense of liveness already encouraged by the camera feed and streaming data visualisation facets of the interface: a liveness that was complicated by the call-and-response nature of the control system.

The design of the Command Centre space drew not only from references to existing sci-fi visual culture but also adopted aspects of the qualities of cinema, pervasive games and theatre set design. In particular the merging of large-scale projection, minimal props and actual functioning communication technologies shares much common ground with other art-oriented research projects emphasising spatial exploration.

Figure 11. Visitors discuss navigation strategies. Photo Credit: Schofield & Schofield.

Although a number of past projects have used remote vehicle technologies, we are unaware of other projects which centre strongly around the remote control of an exploratory vehicle, combined with these performance-oriented elements and identify an opportunity for significant further research and creativity in this area.

White, Male, Robotic Privilege.

As discussed at length, *FieldVenturer* was intended to function as an experiment in exploring space. However, in discussing its design, the motivations behind it must be acknowledged and explored. Behind the *FieldVenturer* project is a long-time, shared fascination on our part with the history of exploratory vehicles both in real life and in literature. This fascination was a significant factor in our early interest in model making and toy robotics, which in turn influenced our individual choices to pursue careers in the arts and research.

FieldVenturer is a project that we had discussed for several years and was eventually brought into the world through a small commission for the Learning programme of an art gallery. As artists, we had a strong desire to play with the visual languages involved, to experiment with the control and motor systems required and in particular to build a functioning remote control robot. For creative individuals, this is obviously not an unfamiliar feeling; art projects are invariably motivated by an interest in both the intellectual and the visceral experience of designing, building, operating and showing a piece of work. In the case of *FieldVenturer* this was particularly powerful and part of the motivation behind the project was to look closely at our fascination with the themes of the work and subject it to an objective critique .

An early reviewer of this paper commented that she/he was 99% certain that the artists were men and few viewers would disagree that *FieldVenturer* is a stereotypically masculine piece of work. It resides in the dead centre of a Venn diagram of archetypal interests for thirty-something, white, middle-class, technically-inclined, Western-European men: all of which we are. Its visual references are lifted virtually unaltered from NASA documentaries, Bond movies, 1980s toy commercials and

Figure 12. Rover Graphics. Photo: Schofield & Schofield.

science fiction novels. It must be acknowledged that even as individuals with left-wing political views and - we believe - humanist stances on issues of displaced power referred to earlier, we are not immune from the fascination of complex, loud, fast-moving, dangerous or even deadly pieces of machinery.

FieldVenturer is comprehensively over-engineered, ludicrously over-sized, unnecessarily hard-edged and covered in garish transfers. It rolls (albeit very slowly) on chunky caterpillar tracks and its motors and gearboxes are satisfyingly loud. It captures sensor data from its surroundings and presents them without context or much explication as official looking graphs. The Command Centre installation is also disproportionately grand. It looms over the viewer, full of visual detail and busily scrolling displays and blinking lights. So although *FieldVenturer* represents an unusual way to explore spaces, it also draws upon the spectacular and visceral pleasure of amplified input and the sensation of control.

Approaches to the design and building of drone vehicles seems inextricably connected to these military and industrial visual languages and the particular constructions of space that go with them. As discussed, part of the motivation behind *FieldVenturer* is to interrogate these visual languages. Their use in the installation are carefully considered in terms of preparing the audience for a particular type of engagement and scaffolding the specific types of interaction described earlier in this paper. However, the fact that in the case of *FieldVenturer* these military-industrial motifs are presented in a theatrical and deliberately absurd way does not make them less problematic in that what we are presenting is a barely modified version of the systems we wish to critique. What *FieldVenturer* offers through its particular take on time, space and exploration then is not an alternative to patriarchal readings of public space but a space in which to explore, critique, play with and hopefully subvert them. We hope that by placing these readings and their associated visual languages centre stage, we are providing a starting point for this process.

Future Directions

FieldVenturer_01 was intended to function as a test run for a range of different deployments. The event was successful in proving that the system could perform reliably in public and in providing a starting point from which to begin to explore the concerns discussed above as well as receiving enthusiastic feedback from audience members. Having successfully deployed the Rover and its Command Centre within the relatively controlled surroundings of a pair of art galleries, we are keen to experiment with different types of public space and are planning further missions. From our informal observations of the event, several areas of interest have emerged which we intend to pursue in further events.

As discussed, the Rover's low angle of view and the particular way in which it moves through its environment necessitates a detailed interrogation of space. This interrogation is often collaborative and is articulated explicitly: people discuss routes, identify objects and speculate on what might be around the corner. In future deployments we hope to examine this phenomenon more closely.

The way in which *FieldVenturer's* control system relies on different configurations of time is also a future area of inquiry. The 3-5 second latency of the video stream, combined with the call-and-response motor controls and nearly-instantaneous feedback from the sensors formed an unusual set of conditions that we feel might have interesting implications for the design of other communication and control technologies.

Future deployments might include explorations of familiar public spaces, enabling members of the public to discuss and recontextualise their surroundings. Other outings may include spaces that are important to public life but that are normally considered off-limits to members of the public, such as political buildings, archives, energy infrastructure or sensitive historical sites. Finally, we speculate that *FieldVenturer* might be used as an interesting way to experience wild spaces, exploring the natural environment from a non-human perspective.

We also hope to further develop the formal qualities of the Rover and its Command Centre to foreground discussion of the dominance of certain manifestations of class, ethnicity and gender in the way that unpiloted machines are used in the conception and construction of space. By starting from a visual strategy of faintly absurd, military-industrial motifs, we hope to spark discussion during events in the hope that visitors might challenge and suggest alternatives to our approach.

In this respect our strategy in future deployments might take one of two directions. We could continue to develop *FieldVenturer* in its current form, further exaggerating its formal qualities to make them even more explicit. Alternatively, we might reconfigure further deployments to include a participatory design element, inviting members of the public to contribute to the design of the Rover, the Command Centre and their specific functions. Through further exhibition and discussion at RTD 2017 and through further deployments, we hope to develop one or both of these strategies further.

References

AND(Abandon Normal Devices), (2016). Project Daedalus. Available at http://www.andfestival.org.uk/projectdaedalus/ [accessed 26/09/2016].

Baltic Centre for Contemporary Art., (2016).What's On Guide. Available at http://www.balticmill.com/calendar?date=2016-05-26 [accessed 26/09/2016].

Bleicher, A., (2010). Eyes in the sky that see too much [update]. IEEE Spectrum, 47(10), pp.16-16.

Benedictus, L. (2014). The artists who are giving a human face to the US's "bug splat" drone strikes | World news | The Guardian. Retrieved October 10, 2016, from https://www.theguardian.com/world/shortcuts/2014/apr/07/artists-give-human-face-drones-bug-splat-pakistan.

Bridle, J. (n.d.). Drone Shadows 001-002 : James Bridle. Retrieved October 10, 2016, from http://shorttermmemoryloss.com/portfolio/project/drone-shadows/.

Christ, R.D. and Wernli Sr, R.L., (2013). *The ROV manual: a user guide for remotely operated vehicles*. Butterworth-Heinemann.

Csikszentmihályi, C (2009) The big Round Table. Available at: http://www.thebigroundtable.com/stories/the-robots-of-resistance [accessed 26/09/2016].

Green, G (1996) *Gregnik (Proto 1),* [Mixed Media]. Newcastle Upon Tyne: Meadow Well.

Graham, S. (2016). Vertical : the city from satellites to bunkers.

Siddiqi, A.A., (2000). C*hallenge to Apollo: the Soviet Union and the space race*, 1945-1974.

Domingo, V., Fleck, B. and Poland, A.I., (1995). SOHO: the solar and heliospheric observatory. *Space Science Reviews*, 72(1-2), pp.81-84.

Kaufman, M. and Musk, E., (2014). Mars Up Close: Inside the Curiosity Mission. National Geographic Books.

Lakoff, S.A. and York, H.F., (1989). *A Shield in Space? (Vol. 1)*. University of California Press.